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RELICT CRYSTALLINITY AND QUALITY OF BASALT FIBERGLASS (MÖSSBAUER SPECTROSCOPY)

N. E. Ablesimov,[1] Yu. G. Malova,[1] and S. I. Bondarevskii[1]

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The Mössbauer spectroscopy method is used to identify the presence of titanium-magnetite and magnesian olivine in basalt-fiber samples. These impurities may be the reason for the deterioration of glass fiber quality in the duplex process.

The urgency of replacing asbestos crystalline fiber by basalt fiberglass is dictated by hygienic standard GN 2.2.5.1212-03 "Maximum Admissible Concentrations of toxic agents in the work zone" effective 15.06.03. The phase (mineral) composition of raw material may significantly affect the specifics of basalt fiberglass production and its quality.

Basalt material, whose chemical composition is shown in Table 1, may contain olivine (MgFe)[SiO_4] and titanium magnetite (Fe)[$FeTiO_4$] [1] impurities. Both minerals melt at temperatures exceeding the heating temperature in the duplex process (1450 – 1500°C): magnesium olivine melts in the interval of 1600 – 1750°C (depending on magnesium content) and titanium magnetite melts at about 1540°C. Consequently, these minerals may be responsible for the relict crystallinity of basalt fiberglass, which impairs the quality of fiber as a consequence of a disturbed homogeneity of material.

The Mössbauer spectra of the initial material (Dmitrov-Steklo JSC, town of Dmitrov, Moscow Region) show titanium magnetite sextets (Fig. 1*a*) and the spectra of material from the Bazalit DV Works in Khabarovsk (Sviyagino deposit in the Primorskii Region) exhibit the magnesium olivine doublet (Fig. 2*a*) and the titanium magnetite sextet (Fig. 1*b*). Consequently, the presence of unmelted crystals of these minerals has to be reflected in the quality of fiberglass, particularly, in producing continuous fiber. Figure 1*c* shows the Mössbauer spectrum of the magnetic fraction of initial

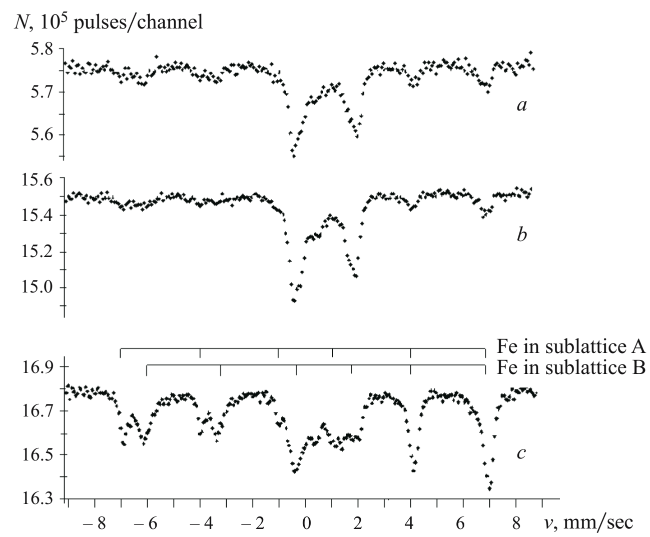

Fig. 1. Mössbauer spectra of initial basalts: *a*) Dmitrov-Steklo JSC; *b*) Bazalite DV Khabarovsk Works; *c*) magnetic fraction of basalt from Dmitrov-Steklo, i.e., titanium magnetite; *N*) count rate of Mössbauer gamma quantums. pulses in the multichannel analyzer; *v*) Doppler velocity of Mössbauer spectrometer vibrator.

[1] Far Eastern State Transport University (FESTU), Khabarovsk, Russia.

TABLE 1

Sample	Mass content, %												
	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O	calcination loss
Dmitrov-Steklo JSC	48.95	1.90	15.42	5.38	7.36	0.09	5.39	9.01	3.71	0.87	0.55	0.00	0.94
Bazalit DV Khabarovsk Works	41.65	2.42	12.46	5.63	6.53	0.08	14.06	9.68	4.13	1.57	1.13	1.01	1.06

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TABLE 2

Spectrum	Isomeric shift, ± 0.05 mm/sec	Quadrupole splitting, ± 0.10 mm/sec	Effective magnetic field strength on nuclei of iron-57, ± 5 kOe	Partial spectrum of Fe
Fig. 1*c*:				In titanium
Sublattice A	– 0.05	–	495	magnetite
Sublattice B	0.00	–	460	
Fig. 2*a*	1.15	2.92	–	In olivine
Fig. 2*b*	1.19	2.96	–	The same
Fig. 2*c*	1.14	2.93	–	″

material from Dmitrov-Steklo JSC used to determine the parameters of superfine splitting of the titanium magnetite spectrum. The Mössbauer parameters of the partial spectra of samples are shown in Table 2 (source ^{57}Co in Rh, an isomeric shift with respect to α-iron).

The Mössbauer spectra of the melt cooled in a crucible (Fig. 2*b*) and of the melted material precipitate (Fig. 2*c*) exhibit a typical doublet of the quadrupole splitting of Fe^{2+} (2.96 mm/sec) in the olivine crystals (closer to forsterite). This shows that the melting temperature in the duplex process is not sufficient for adequate processing of olivine basalt into fiberglass. Nanosize olivine crystals most probably remain in the melt after passing through the spinneret. Due to the limited phase sensitivity of Mössbauer spectroscopy (5%), their presence in fibers may not be detected by this method.

X-ray phase analysis as well may fail to register this phase when it is present in a quantity below 5%.

Thus, in order to obtain high-quality (continuous, superfine) glass fiber in a duplex process, it is recommended to use basalts free of olivine. Furthermore, the material has to undergo preliminary magnetic separation to separate titanium magnetite. Note that the authors in [2] report the unacceptability of basalt with a high content of magnetite and olivine (over 10%) for stone casting [2].

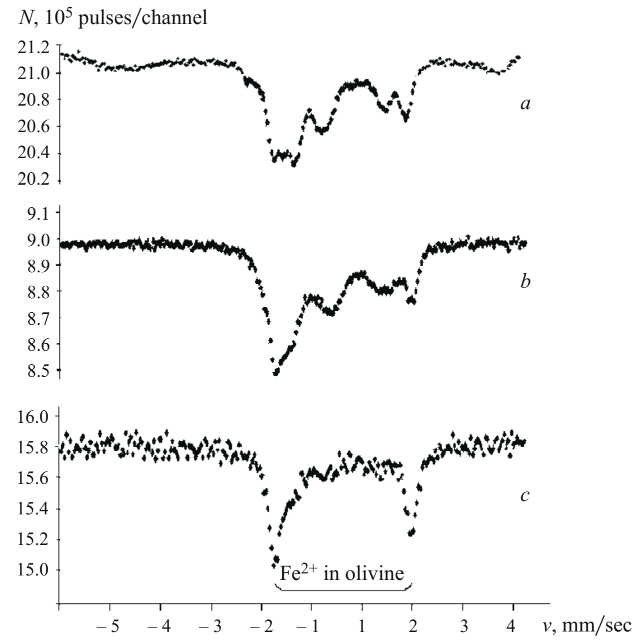

Fig. 2. Mössbauer spectra of samples from Bazalit DV Khabarovsk Works: *a*) central part of initial basalt spectrum; *b*) cooled melt in a crucible; *c*) sediment of the melt in the crucible; other notations same as in Fig. 1.

The presence of titanium magnetite and magnesium olivine in the production of basalt glass fiber may impair the product quality using the duplex process.

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